gen is, however, not to be found in the soil, but the examination of the drainage waters from the different plots exhibits so large a content of nitrates, that calculation leads to the belief that in the case of ammonium salts and nitrate of sodium the loss of nitrogen chiefly takes place in this manner. Chemists knowing that ammonia is readily absorbed and firmly held by soil, had never anticipated that so considerable a loss might occur by drainage. It plainly appears, however, from these results, that ammonia when applied to the soil is quickly converted into nitric acid, and in heavy rains may be easily washed out. During autumn and winter there is little evaporation from the soil, and no consumption of water by a growing crop; as soon therefore as the surface soil is saturated most of the subsequent rain-fall will pass into the subsoil, or find its exit through the drains. The authors calculate that if the drainage water contains 1 part of nitrogen in 100,000, and many of the waters analysed were much richer, there will be a loss of 2·26ths of nitrogen (equal to about 23 lbs. of guano) for every inch of rain that passes beyond the reach of the roots. It is evident, among other conclusions from these important facts, that ammonia should only be applied to the land in the spring, when the crop is able to make immediate use of it. It may also be found that on gravelly and sandy soils, which have little power of holding water, organic forms of nitrogen, as rape cake and farm-yard manure, may be more certain in their effects than ammonia or nitrates. The organic manures being only slowly rendered soluble in the soil, can suffer comparatively little loss from sudden rain. The subject of the economic application of nitrogen is being further investigated at Rothamsted.

We have no space to do more than allude to the researches which have been conducted at Rothamsted in the department of animal chemistry: the experiments on the fattening of stock, and on the composition of the carcase produced, have been equally important in their results with those field experiments we have referred to. Of the indebtedness of Science to Mr. Lawes' unique and costly experiments we need not speak, the facts are so plain that they speak for themselves. Nor need we state the moral. The addition to the national wealth which has accrued from the discoveries made by Mr. Lawes is already enormous. It must be borne in mind that this benefit has arisen from *accidental* researches, for Mr. Lawes was not compelled to take them up, nor is he bound to continue them. Now if such work is not national work, The Royal Observatory ought to be shut up to-morrow, for the work done there is not one jot or tittle more important.

DR. LIVINGSTONE

THE telegram, dated at Aden on the 23rd of this month, announces that Lieut. Murphy is bringing the body of Dr. Livingstone down to Zanzibar, while Lieut. Cameron has passed onwards to Ujiji to recover Dr. Livingstone's papers and to continue his work. The story of those faithful negroes having carried the body of their beloved chief over hundreds of miles is one of the most romantic in history, and is a fitting close to the noble life of the great explorer. Dean Stanley, we are informed, has proposed that the remains of Livingstone shall find a last resting-place in Westminster Abbey. Yesterday (the 25th) was the last day on which instructions could be sent out by telegram touching the disposal of the body. We cannot believe that the necessary orders have not been despatched; for the wishes of the country are well known, and have been sufficiently expressed. With the body will arrive all Livingstone's faithful followers, who were engaged on the understanding that they were to receive a certain fixed monthly payment. There were Chumah and the two or three other men who had been with him since 1865. There were Jacob Wainwright and the other Nassick boys, and the men sent up to Unyanyembe in the summer of 1872; and there were the men engaged in the interior by Dr. Livingstone himself. A sum of about 1,000*l.* will be required to pay off these loyal and faithful servants of Her Majesty's Consul. Yesterday was the last day on which an order for the payment could be sent out. Has this been done? The people of England have a right to an answer, and an immediate answer, for if the Government hesitates, the country will never allow this disgrace to come upon it.

As soon as the full details arrive by the next mail, it will be fitting that we should give our readers a memoir of the illustrious martyr to Science who has passed away. But now we desire to know—and all England will join with us in the inquiry—whether orders were sent out by telegram on the 25th, respecting the disposal of Dr. Livingstone's body, and the payment of his followers, the devoted servants of Her Majesty's Consul?

Lieut. Cameron, in conducting the search expedition, has suffered terribly from fever and ophthalmia, and has been obliged to incur heavy expenses. But he has displayed the best qualities of an explorer. He is a good manager of natives, an excellent walker, an accurate astronomical observer, a linguist, and a man of indomitable perseverance. He is now pressing forward on a perilous and important duty, and we trust he will carry with him the generous sympathy of the Geographical Society, and of the public generally.

POST-TERTIARY GEOLOGY

The Great Ice-Age and its relation to the Antiquity of Man. By James Geikie. (W. Isbister and Co. 1874.)

I.

EVERY field-geologist, who works in northern latitudes, soon comes to know what is meant by Drift. In his attempts to trace the superposition and run across the country of the solid rocks, he is always sooner or later brought up by coming across masses of stony clay, gravel, and sand, which bury them to greater or less depths, and more or less completely hide them from view. These superficial accumulations lie indifferently on all members of the bedded formations; they occur now in detached patches, and now spread like a pall over vast tracts of country.

In the latter case it is clear that they would soon make their presence felt by the way in which they effectually mask the geological structure of the ground they cover; it was impossible, therefore, that they could be for long ignored altogether, but they seem for a time to have been looked upon as something very inferior in interest and importance to the older and more regular formations, in some cases, perhaps, as little more than troublesome hindrances to the making of a good geological map. Thus it came about that deposits of this class were lumped together under the comprehensive title of Diluvium or Northern Drift: and that, in the few cases where any geologist thought them worthy of more than a simple recognition, the explanations offered of their origin were crude and unsatisfactory. Some of these explanations we may just glance at. In the days when evolution and continuity were doctrines yet undreamed of, it was imagined that between any two consecutive geological epochs there intervened a period of chaotic turmoil, one result of which was, that a clean sweep was made of the life of the epoch that had just closed, and the ground prepared for the introduction of the life of that which was to follow. Supposing this to have been the general course of past events, some referred diluvial accumulations to the series of convulsions which came in like a great gulf between the age of man and the last of geological eras. It could not be reasonably objected to such an hypothesis that it called to its aid agencies the like of which we had never seen, and the like of which, as far as our knowledge of the economy of nature went, it was most improbable had ever been in operation; there was the ready answer, that during periods which were essentially abnormal, anything was possible. This made such explanations easy to frame and easy to uphold, and they commended themselves readily to the indolence of mind and impatience of accurate thought from which few of us are altogether free. The same may be said of the notion suggested by, but we cannot say based upon, the phenomena of the great ocean wave of earthquakes, "that somehow and somewhere in the far north a series of gigantic waves was mysteriously propagated," which "were supposed to have precipitated themselves madly on over mountain and valley alike, carrying along with them a mighty burden of rocks, stones, and rubbish," and that by this means the piles of diluvium had been heaped up. Again, the name diluvium was founded on the idea that its deposits were the relics of Noah's flood; and the notion that we had in them a proof of the accuracy of the Biblical record was so very welcome, that it was accepted and stuck to in spite of the absence of evidence in its favour, and so contributed, perhaps as much as anything else, to postpone the true solution of the problem.

But by degrees light began to dawn on the subject. Playfair had attempted to turn the attention of geologists to the proper quarter, when he suggested that the most powerful agents which Nature employs for the moving of rocks are the glaciers; but his hint lay for a while unheeded. In 1837, Agassiz arrived at the conclusion that the glaciers of the Alps had been formerly far larger than at present. He had studied the smoothed and furrowed surfaces which occur everywhere below glaciers, and had found that the rocks displayed markings exactly identical with these far beyond the range of the present ice. He explained his views to Buckland, who then saw the meaning of certain surface features which he had observed, but had not previously understood, in the British Islands. The two geologists visited Scotland together in 1840; found over the length and breadth of the land scorings and polishings which ice—and, as far as their knowledge went, nothing but ice—could have made, and came to the conclusion that the whole country had been once swathed in one widespread ice-covering. About the same time Sir Charles Lyell attributed the formation of portions of the Scotch drift to the action of land-ice.

The right clue was now found, and it only remained for others to follow it up. A great step was made by Prof. Ramsay when, some ten years later, he deciphered the story written on the Drift-beds of North Wales, and determined the broad succession of physical changes that had led to their formation. He pointed out that there had been two periods of cold, the first of intense severity, and the second less rigorous, and that between the two there came a milder interval, during which depression brought the sea up the flanks of the mountains to a height of 2,300 feet above its present level.

Still however the importance of the Drift was far from being fully recognised. For many years no notice whatever was taken of it on the maps of the Government Survey; and when at last it met with a tardy recognition, Drift was still for a while Drift "and it was nothing more," a something agriculturally important and therefore not to be passed over by the economic geologist, but hardly a great formation with a story to tell as long, as varied, and as interesting, as any that geology had hitherto revealed to us. It is significant that ever so eminent a pioneer as Prof. Ramsay did not deem these deposits worthy of more than incidental notice in his otherwise exhaustive Memoir on the Geology of North Wales. The Drift in fact was somewhat on the position of a *nouveau riche*, who is trying to work his way into "society," and it had up-hill work before it was admitted into the exclusive circle of the old respectable formations.

But its turn came at last, and amid the band of geologists, who have helped in the work of securing for it the attention to which it is fairly entitled, the brothers Geikie occupy prominent places. The one gave us in 1863 his paper on the phenomena of the Glacial Drift of Scotland, in which he offered a masterly summary of all that was known on the subject up to the date of its publication, and settled for ever the claim of land-ice against ice-bergs to have been the agent that formed the Scotch Till; and now the other comes before us with the goodly volume, whose title stands at the head of this article, and which can be cordially recommended both to the geologist and the general reader. Its account of the labours and conclusions of previous workers is all but exhaustive, but it is far more than a mere *résumé*; a long practical acquaintance with Drift-deposits has enabled the author to add materially to our knowledge of the course of events that accompanied their formation, and in some cases has led him to demur to views hitherto all but universally accepted; and his own contributions and criticisms are as remarkable for the boldness of their originality as for the soundness of the reasoning by which they are upheld. At the same time the explanations are so full, and the method of handling so free from technicality, that with a moderate amount of attention the book may be understood, and its reasoning followed, by those who had previously little or no geological knowledge.

A large part of the work is taken up by a careful and detailed description of the Drift-beds of Scotland, which country the author has chosen as a typical area. A better selection could not have been made, for in no country perhaps are these deposits so largely developed, and nowhere have they been so elaborately worked out as by the distinguished band of geologists who have made Scotch glacial formations a special study.

The first seven chapters are devoted to a description of the Till, the lowest member of the Scotch Drift; and an explanation of the line of reasoning that has led geologists to acquiesce almost unanimously in the opinion that it was formed on land beneath a sheet of ice, which, during a period of intense cold, overspread the whole country, and pushed its way far out over the shallow bed of the surrounding sea.

So far the author has only been repeating and enforcing the conclusions of his predecessors, but in chaps. 11—14 he enters on ground which is all but his own. It has been long known that layers of well-bedded sand and gravel occur in the heart of the Till, and between it and the older rocks. These deposits however are local and of small extent, or had been detected only in borings or underground workings, and had had comparatively little attention paid to them. Mr. J. Geikie has for the first time pointed out that in spite of their small development they are full of meaning; and that, when this meaning is realised, the fragmentary nature of their occurrence is only what is to be expected, and that the wonder is, not that there is so little of them left, but that any of them should have survived to tell the tale which he has so ably extracted from them. And the story they tell us is this. They are evidently the products of running water, alluvial or lacustrine deposits mostly; now former observers had realised in a vague sort of way that they were a proof of changes of climate, which permitted water to flow over what had been before an ice-bound waste, but we have now clearly brought before us that the abatements of the intense cold, which these beds indicate, were not local and temporary, but wide-spread and of long duration, and that they recurred several times during the period of the first great glaciation. Thus we are led to see that the first subdivision of the great ice-age was not one dreary unbroken lapse of Polar winter, but that it included mild intervals, when the ice shrank back, possibly disappeared altogether, when vegetation reappeared, and when herds of the great mammals returned from the southern retreats into which they had been driven during the most intense phases of the cold. And these facts enable us to realise more vividly the immense lapse of time represented by one division alone of the Glacial Formation. For if "we consider that the succession of changes happened not once only, but again and again, we cannot fail to have some faint appreciation of the lapse of time required for the accumulation of the Till and the Interglacial Deposits." Lastly Mr. Geikie has pointed out that these alternations of intense glaciation and comparative mildness are fully in accordance with the theory so ably expounded by Mr. Croll, that changes in climate are due to the combined effect of the Precession of the Equinoxes and variation in the eccentricity of the earth's orbit, a theory which he has lucidly expounded in chaps. 8—10.

We next come to certain deposits, the meaning of which seems first to have been clearly read by the author of the present work. At last the conditions which gave rise to the Till began to pass away and the climate to improve slowly, and the great glaciers ceased to be confluent; a depression of the land ensued so that the sea followed the retreating margin of the ice; but after a while, perhaps owing to an upward movement, the glaciers terminated on dry land. Mountain peaks now began to rise above the ice, and showered down on to its surface loads of *débris* torn from their exposed faces by frost. As the burden was shot over the ends of the glaciers, it gave rise to huge heaps of morainic rubbish, which at first fell into the sea, and afterwards, as the ice drew back, was shed upon the land. In this way were formed the subdivisions of the glacial formation which the author has distinguished as Boulder Clay and Morainic Rubbish. During this period the author believes that many of the erratic blocks, which form so conspicuous a feature among glacial deposits, were stranded from the ice-sheet as it drew back; and he gives good reasons for preferring this explanation to the older notion, which supposed these travellers to have been dropped from ice-bergs during the submergence which came a little later on.

As the climate gradually improved, the melting of the ice swelled the rivers and gave rise to mighty floods, which thundered down the narrow mountain glens, sweeping before them portions of the Till and Morainic rubbish, and, when they emerged on the open valleys of the lowlands, spread out the worn and rounded materials in broad sheets of gravel. One point here we must pause specially to call attention to. Geologists had long been aware of the disappearance of the great ice-sheet and of a gradual submergence of the land which followed it, but we now learn that the first of these events had made considerable progress, perhaps had been completed, before the second had fairly set in.

The first act of the drama we are looking at may be said to close here; the second opens with the commencement of the submergence just mentioned. The land began to sink and went down till the sea reached to some 1,200 feet, perhaps in some cases to nearly double that amount, above its present level; and as each of the previously formed Drifts, Till, Boulder Clay, Morainic Rubbish, and Gravel, was brought under the action of the waves, they sifted and sorted it, washing out the fine dirt, and rounding and reducing in size the pebbles; and in many cases the clean gravel and sand so formed were piled up along each successive coast line in mounds and long ridges, which still retain the distinctive outline originally impressed on them by wave- and tidal-action. These hummocky piles and ridges are known as Kames or Eskers. That many Kames owe their present shape in the main to the direct action of the sea alone there can scarcely be a doubt; we find them sometimes for instance enclosing hollows *without any outlet*, a little tarn or peat moss occupying in some cases the central depression, and in such a case they must have been piled up by shifting currents, for in no other way could the closed basin in the middle have been produced. But many so-called Kames are only the remnants of large sheets of gravel, the greater parts of which have been carried away by denudation. It would be better perhaps to restrict the term to those mounds which were piled up originally very much as they stand now. Even with this limitation, however, Kames are plentiful enough, and they are found in greatest abundance at the spots where the currents tending to their formation must have prevailed as the land went down; in cols, then straits connecting opposite firths from which tides would flow in on either side; at the openings of mountain valleys, where the stream with its gravel burden was then met by the incoming tide; on low plateaus lying between what were then estuaries, over which opposing currents would sweep each high tide; and in other similar situations.

But were the Kames formed as the land sunk, or during its subsequent emergence? One would be inclined to say during the latter period, for any heaps piled up by the incoming sea would be liable to be swept away when they again became exposed to wave-action as the sea retreated. Nevertheless, Mr. Geikie—and he is supported by other observers in his opinion—holds that it was during the period of depression that kame-building went on, for the following reasons. The material of the Kames is, for the most part, fine and well rounded, and it is a very rare thing to find a large angular boulder in the heart of a Kame; hence it is believed that during the formation of the Kames the climate had so far mended that glaciers no longer existed, and that therefore there were no icebergs to strew the sea-bottom with travelled blocks. Erratics are, however, common perched on the outside of the Kames, and hence it is concluded that at some point in the period of the submergence cold again began to come on, that glaciers reappeared and gave rise to icebergs which bore away these blocks and dropped them where they are now found. That there was a return to cold conditions we know from other evidence, and with the exception of the difficulty just mentioned, which after all is not very serious, for the Kames we have may be only the relics of a body originally much more numerous, the explanation accords well enough with our knowledge of the facts. But the thought crosses the mind that it is not very often that we have an opportunity of seeing into a Kame, or rather, that we see the outside much oftener than the inside, and that this possibly may be the reason why erratics seem to be more plentiful in the one place than the other.

A. H. GREEN

(*To be continued.*)

OUR BOOK SHELF

Mineralogische Mittheilungen, 4th Heft. (Vienna, 1873.)

THE present number of the *Mineralogische Mittheilungen* forms the 4th volume of the series, commenced in 1870. It is published under the auspices of the K. K. Geol. Reichsanstalt, and in connection with their quarterly Jahrbuch, but forms properly in itself an independent journal. It is probably the only periodical devoted exclusively to mineralogy, and thus already occupies an important place among German scientific serials. The list of papers which appear in this number will give a good idea of the position which the journal occupies:—Mineralogical observations in the Argentine Republic, by H. Stelzner (embracing—minerals occurring in the granite quartz masses of Cordoba; minerals associated with the granular limestone; also analyses and special description of Triplite, Jamesonite, Enargite, Linarite, &c.); eruptive rocks of Banat, Hungary, by Niedzwiedzki; crystallised magnesite from the Northern Alps, by J. Rumpf; mineral observations from the Bohemian Forest, by Helmhacker; brief notices of various minerals, Grunochite, an optically uni-axial diamond, native copper, Roselite, &c. The number opens with a short obituary notice of Naumann.

The Mittheilungen are under the charge of Prof. Tschermak, so well known through the scientific world for his many and valuable contributions to mineralogy and lithology.

Prof. Tschermak occupies the position of Director of the Royal Mineralogical Museum of Vienna, a collection which in beauty and completeness is not inferior to that of the British Museum, while it surpasses the latter in the arrangement of the objects exhibited, especially in reference to the good of the general public. The Museum has been much enriched within the last four months by the acquisition of a number of interesting things from the Vienna Exposition. The collections are opened two mornings in the week, for the benefit of the public, opportunities which are well made use of, while the Cabinet is accessible on every week-day to those who are there engaged in regular work. The results accomplished in the Mineralogical School thus formed in connection with Prof. Tschermak and Dr. Schrauf do a considerable part toward supporting the *Mineralogische Mittheilungen.*

The Geological Reichsanstalt, now under the direction of Franz Ritter von Hauer, has carried on its work for twenty-seven years. The results are not only of the greatest importance in developing the resources of the Empire itself, but, as the work engages the best talent, and is consequently carried on according to the highest standard of pure science, the yearly labours are adding vastly to the fund of geological knowledge, and helping to solve many of the difficult problems of the science. The building occupied by the Reichsanstalt contains the various working-rooms, and the extensive collections, complete naturally in all matters pertaining to Austrian Zoology. The immediate results of the survey are first made known in the Evening Sessions, which are held on the first and third Tuesday of each month from November to May. They are attended regularly by some thirty or forty of those interested in such subjects, and form a pleasant opportunity for those of common interests to meet together informally. The stranger is continually impressed with the active spirit, and especially with the community of feeling, among the scientific men of Vienna; the latter has undoubtedy great influence in giving the city the prominent position which it occupies among the different scientific centres.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Zoological Nomenclature

FROM time to time an idea is started that Zoology is breaking down under the weight of its synonymy. With entomologists I have frequently contended that so far from this being the case, there is, on the contrary, an almost marvellous agreement in the generic and specific names used, especially when we consider the extent of the bibliography and the vast number of the species. After reading in NATURE, vol. ix. p. 258, Mr. Wallace's review of Dr. Sharp's pamphlet, I bethought myself of comparing the two best known catalogues of European Coleoptera, viz., Schaum's, published at Berlin, in 1862, and De Marseul's, at Paris, in 1866. Perhaps the results of the examination of the first six families in the two works will suffice. It must be premised that Schaum's is strictly confined to European species, while De Marseul's embraces as well those of the "basin of the Mediterranean in Asia and Africa." As to the genera, in the Cicindelidæ there are two in each. In the Carabidæ, Schaum has 98 genera and de Marseul 118; of the latter four are not adopted by Schaum and the remainder are extra-European. In the Dytiscidæ Schaum has 15 genera, De Marseul 17. In the Gyrinidæ there are two genera in Schaum, and three in De Marseul, the third being